Generalized Multiple Description Coding through Unequal Loss Protection

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Introduction

- Goal: Graceful degradation of image quality in the presence of increasing description (packet) loss.
- Method: Use multiple Reed-Solomon codes of different strengths.
- Results: Unequal Loss Protection (ULP) significantly outperforms previous solutions to the generalized Multiple Description problem.

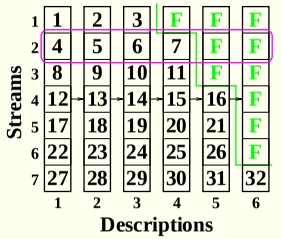
Progressive Image Compression

- An approximation of the image can be decoded from a prefix of the compressed data.
- The longer the prefix, the better the image quality.
- The wavelet-based SPIHT image coder is progressive. (Said and Pearlman 1996)

Systematic Reed-Solomon Codes

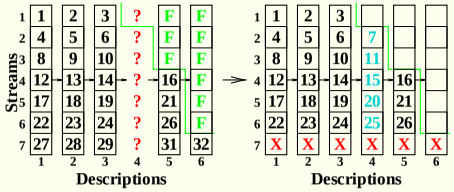
- An (N, k) code maps k source symbols into N encoded symbols.
- Any k of the encoded symbols can be transformed into the k source symbols.
- The first k of the encoded symbols are identical to the source symbols.

Unequal Loss Protection Framework

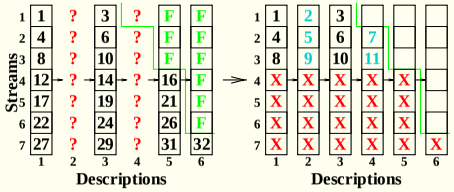


- Each row is an independent Reed-Solomon code.
- Every code loses the same number of symbols.

Loss of One Description



Loss of Two Descriptions



MD-ULP: Drawing the Green Line

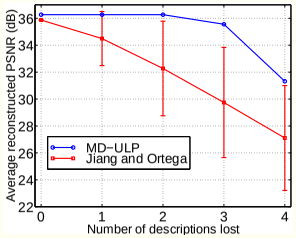
- Estimate a PMF of channel loss conditions.
- Use ULP assignment algorithm. (Mohr, Riskin, and Ladner. DCC 1999)
- Maximize the expected PSNR at the receiver.

Advantages of MD-ULP

- Efficient Source Coding: Unmodified SPIHT.
- Modularity: Any progressive source coder and any allocation algorithm.
- Quantifiable Overhead: Redundancy is distinct from source data.
- Perfectly Balanced Coding: The number of received descriptions determines image quality.

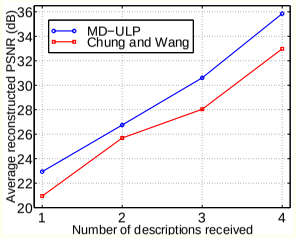
Comparision with Jiang and Ortega '99

512×512 Lenna image at 1.0 bpp total rate (20% redundancy) with 16 descriptions.



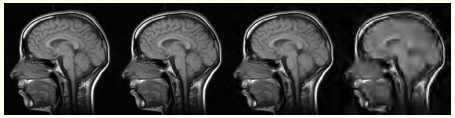
Comparision with Chung and Wang '99

256×256 Lenna image at 1.22 bpp total rate (27% redundancy) with 4 descriptions.



Magnetic Resonance Image

256×256 brain MRI at 1.0 bpp total rate, channel optimized for an exponential PMF with a mean of 10%.



174 descriptions: 10%, 20%, 30%, and 40% loss rates.

Conclusion

- MD-ULP can generate any number of descriptions.
- Protection can be optimized for channel conditions.
- Information is dispersed equally among descriptions.
- Explicit channel coding is a viable alternative to joint source-channel coding.

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